

**Status and Progress of the
U.S. Geological Survey's
National Cooperative Geologic Mapping Program
Through Fiscal Year 1999**

Secretary of the Interior

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National Geologic Mapping Act of 1992 and National Geologic Mapping Reauthorization Act of 1997

The availability and effective utilization of natural resources is fundamental to sustain human existence on planet Earth. A basic requirement for identification, delineation, and sustained use of earth resources, including water, mineral and biologic resources, is the availability of detailed geologic mapping. Unfortunately, less than 20 percent of the United States is adequately mapped to meet these needs and an even smaller fraction is mapped using digital technology.

Growing concern over effective stewardship of our environment is producing a myriad of rules and regulations directed toward maintaining and improving our habitat. The ultimate repository of our waste products is the earth, and geologic maps are needed to identify and delineate the rock units that are capable of containing them effectively.

As the population of the earth continues to increase, the effects of natural hazards loom even greater. The identification and mitigation of such phenomena require the use of detailed geologic maps. Increasingly, digital technology is needed to interpret three-dimensional geologic map data and to expedite decisions on the use of earth resources. Geologic maps are being integrated into digital Geographic Information Systems (GIS) that display the location and abundance of earth resources, risks from natural hazards, and the susceptibility of the surface and buried aquifers to contamination. As used in GIS, geologic maps constitute the basic earth materials framework on which all other information layers are built.

An assessment during the 1980's by the Association of American State Geologists (AASG) found that only 11,000 (18 percent) of the 59,000 7 1/2-minute quadrangles covering the U.S. have been mapped in sufficient detail to be useful in addressing State needs for resource development, environmental protection, and natural hazard identification and mitigation. Only one State, Kentucky, has been completely mapped at a scale of 1:24,000, and even in that State revisions are needed. The latter point illustrates the need to not only complete the coverage of the nation, but also for an ongoing commitment to update and maintain the nation's geologic map information.

For these and a myriad of other reasons, the AASG in concert with the U.S. Geological Survey (USGS) began a planning process in 1988 to develop a geologic mapping program that would produce complete coverage of surficial and bedrock geologic mapping for the nation in a reasonable time frame.

At the outset, it was recognized that the nation has substantial but declining capability in geologic mapping. While the USGS and the state geological surveys are publishing detailed surficial and bedrock geologic maps, the rate of production will not provide adequate coverage of the needed areas in any realistic span of time. Furthermore, the numbers and capability of geologic mappers in the U.S. are clearly on the decline. In recent years, colleges and universities have decreased their attention to field training, with many eliminating such requirements for a geology degree.

Based on these conditions, a plan was developed to introduce an authorizing bill to Congress to mandate production of complete surficial and bedrock geologic map coverage at a scale that would meet national and regional needs for resource development, environmental protection, and identification and mitigation of natural hazards. The nominal mapping scale that was adopted was that of the standard topographic quadrangle map (1:24,000).

The proposed authorizing bill placed the national management responsibilities in the USGS, with advisory support from other involved Federal agencies, state geological surveys, academia, and the private sector. The proposed program consisted of four mapping components: a Federal mapping component, a Federal mapping support component, a state mapping component, and university field training component.

The Federal mapping component recognizes the current Federal mapping program that addresses national needs for geologic map coverage by the USGS and other Federal agencies.

The Federal mapping component encompasses the ongoing efforts of the USGS to develop and maintain related databases in stratigraphy, geochronology, paleontology, geophysics, and other areas. In addition, this component recognizes the need for the development of digital methods for managing and using geologic map data.

The state-mapping component is directed toward meeting those needs for detailed geologic maps at the State and local level. It is recognized that such needs carry some responsibility for State support as well. Thus, the state mapping component was established as a matching-funds program with one-half of the funding to be obtained from non-Federal sources.

The university field training support component is designed to address the national decline in geologic field training. Grants to academic institutions for augmenting graduate and undergraduate field training will be provided with the expectation of increasing the number of field geologists who are qualified to meet the needs of the expanded national geologic mapping program.

It was recognized at the outset that the passage of a bill authorizing the establishment of a national geologic mapping program would require the support of a broad constituency. While the USGS and the AASG have compiled impressive statistics concerning the needs and the status of detailed geologic mapping in the U.S., efforts at passage of such legislation would undoubtedly fail without a public response to support those identified needs.

To develop this public support, the AASG, through the state geological surveys, launched a major effort to identify companies, organizations, and individuals at the national, regional, State, and local levels. The results were impressive, and played a key role in passage of the authorizing legislation.

The authorizing bill was introduced in the Senate by Senators Johnston (Dem., LA), Bingaman (Dem., NM) and Craig (Rep., ID) on May 23, 1991, and in the House of Representatives by Congressmen Rahall (Dem., WV), Vucanovich (Rep., NV), Brewster (Dem., OK) and McCurdy (Dem., OK) on June 25, 1991. The state geologists, working through various state-level groups, were able to enlist a large number of co-sponsors for the House and Senate versions of the bill. At passage, the Senate bill (S. 1179) had 22 co-sponsors, and the House bill (H.R. 2763) had 48 co-sponsors. The result was that, following successful hearings, the bill passed both houses by unanimous consent and was signed into law on May 18, 1992, as Public Law 102-285, The National Geologic Mapping Act of 1992.

Public Law 102-285 authorized the first four years of the National Cooperative Geologic Mapping Program ("the Mapping Program"). Authorization and appropriation levels are listed in the table below. Authorization for the Mapping Program ended in FY 1996. A reauthorization bill for FY 1997 -2000 was passed by the House and referred to the Senate, but the bill died in the closing hours of the 104th Congress. Recognizing the value for cooperative geologic mapping, the President's budget request for FY 1997 included funding for the Geologic Mapping Program under the general funding authority for the USGS at the base level for FY 1997 (\$21.8 M).

The President's budget request for FY 1998 again specified funding for the Mapping Program, albeit at a reduced level (\$20.1 M, an 8% reduction). The 104th Congress restored the proposed reduction for FY 1998 and funded the Mapping Program at \$22.2 M, a slight increase over the previous year. Intense constituent interest in reauthorization of the Mapping Act was expressed early in the 105th Congress. Representative Cubin (Rep., WY) introduced a reauthorization bill for FY 1998- 2000 on February 12, 1997. Following a positive hearing before the House Resources Committee, Subcommittee on Energy and Mineral Resources, the bill was passed by the House on March 11, 1997, and referred to the Senate. The bill was passed by unanimous consent on July 23, 1997, and signed by the President on August 5, 1997, as Public Law 105-36, the National Geologic Mapping Reauthorization Act of 1997.

Activities of the Federal Advisory Committee (1996-1998)

The National Cooperative Geologic Mapping Program's Advisory Committee ("the Committee") first met on April 24-25, 1996, to review the status of the Mapping Program and its Implementation Plan, discuss plans for the future, and to form working groups. During the year, the working groups made recommendations for the future of the Mapping Program, revised the Implementation Plan and evaluated the state and university Requests for Proposals. The Implementation Plan and the Annual Report for FY 1996 were submitted through the USGS and the Secretary of the Interior to the Committee on Resources of the House of Representatives and the Committee on Energy and Natural Resources of the Senate, as stipulated in the Mapping Act.

The Advisory Committee determined that except for an increase in funding, all components of the Mapping Program, as authorized by Public Law 102-285, had been implemented. Future plans focused on increasing partnerships between Federal, State, university, and private-sector groups in the production of geologic maps and in the construction of the National Geologic Map Database. Recommendations were made on how to integrate national, state, and local priorities in the selection and funding of projects, and on ways to address the shortage of trained geologic mappers. Each of these efforts was directed at increasing the effectiveness of geologic mapping and providing geologic map information for the solution of earth science problems that are critical to public safety, and in balancing resource, environmental, and land-use issues.

The Committee met again on April 3, 1997, for the annual review of the progress of the Mapping Program and to review the Mapping Program's new five-year plan, which was outlined at a planning workshop with constituents during February 1997. The Committee heard updates on the status of the National Geologic Map Database, on progress of the matching-funds programs with the state surveys and universities, and on Federal and support mapping activities. The Committee also provided written comments on the Mapping Program's five-year plan during the following year. The comments were incorporated in the revised five-year plan, which is used as the basis for setting priorities and for reporting progress under the Government Performance and Results Act.

The Committee met most recently on April 15-16, 1998 to review the Mapping Program Implementation Plan and progress made during the previous year. In addition, the Committee reviewed the National Geologic Mapping Reauthorization Act of 1997 and planned improvements to the Mapping Act in anticipation of reauthorization for fiscal years 2001-2005. The Committee also commented on revisions to the Mapping Program's five-year plan to bring the plan into alignment with the USGS Geologic Division's new Science Strategy, and with Department of Interior priorities. The Committee also discussed how the Mapping Program could better meet the needs of other Federal agencies, the States, the private sector and academia. The 1998 recommendations of the Committee are summarized in this report.

The Matching-funds components: STATEMAP and EDMAP

The matching-funds program components with state geological surveys (STATEMAP) and with universities (EDMAP) were fully implemented in FY 1996. Federal funding for the STATEMAP component increased in FY 1996 to approximately \$4.4M, more than three times the funding level in FY 1995. The distribution of funds between the Federal and matching-funds components followed the allocation set out in the Mapping Act. The EDMAP matching-funds cooperative with universities was implemented for the first time in FY 1996, with the mandated funding level of approximately \$440K. Funds were derived through decreases to the Federal mapping program component (FEDMAP). Funding was maintained at these levels in FY 1997, and increased slightly in FY 1998 as a small increase was distributed according to the provisions in the Mapping Act.

The number of state geological surveys participating in the STATEMAP component has increased each year. In 1998, matching funds were provided for approximately 150 geologic mapping projects in 43 States. State Mapping Advisory Committees are in place in all participating States and are composed of more than 500 geologic map users from the public and private sectors. These committees set priorities for geologic mapping within each State and rank the top geologic mapping project proposals to forward to a national awards panel managed by USGS. The awards panel, which consists of representatives from the state surveys, universities, and the USGS, evaluates proposals for matching funds awards. Since 1996, forty-eight States have participated in STATEMAP, with well over 200 geologic mapping projects receiving matching funds. Many of these mapping projects have produced multiple geologic maps, thus contributing hundreds of new geologic map products. Likewise, since 1996, sixty-eight universities have received matching funds from EDMAP to train over 130 graduate students to produce geologic maps. Similarly, participation in EDMAP has increased during the first three years of implementation. In 1998, 52 graduate students at 40 universities in 26 States received matching funds from EDMAP. All EDMAP proposals are endorsed by and coordinated with state geological surveys or USGS projects that have a geologic mapping component. Matching funds are awarded by the USGS on the basis of recommendations of an annual awards panel. The panel consists of representatives from universities, state geological surveys, and the USGS.

Issues addressed by STATEMAP and EDMAP projects are well aligned with priority needs for geologic mapping as identified by map users in the State, and include mapping in support of: ground-water resources, land-use planning, aggregate and other mineral resources, and natural hazards, as shown in the charts that follow. A larger proportion of the EDMAP projects address basic research issues, such as the resolution of questions about the geologic framework of various regions of the nation. This focus is consistent with the overall training mission of the EDMAP component, that is, to address the shortage of well-trained field geologists by providing experience in geologic mapping.

Each year, the national awards panels for STATEMAP and EDMAP make recommendations for changes to these program components. When appropriate, changes are made to the annual Request for Proposals (RFP). Recent changes include: revision of the EDMAP RFP to emphasize the training mission of the component, as specified in the Mapping Act; changes in the language of the STATEMAP RFP to encourage state surveys to limit overhead charges to eighteen percent or less; and changes recommended for the FY 1999 RFP to extend eligibility to Senior undergraduates for matching funds to support geologic mapping as components of senior thesis work. The Federal Advisory Committee reviewed each of these changes prior to implementation.

The Federal mapping and support components: FEDMAP

The focus and scope of FEDMAP geologic mapping projects changed dramatically during the 1990s. These changes were based on assessment of stakeholder needs for maps and followed recommendations of a National Research Council study that took place in 1985, and the steps outlined above that led to the National Geological Mapping Act. Federal project evolution continues and incorporates annual recommendations from the Federal Advisory Committee. Additional input was obtained from map users and stakeholders at a National Geologic Mapping Forum and five-year Planning Workshop with stakeholders in 1997 and at three Regional Geologic Mapping Forums that brought clients and stakeholders together with project personnel during 1997. New projects are developed in partnership with partners from other DOI and Federal agencies (e.g., NPS, DOE, EPA, and others), and with state surveys. Ongoing projects are undergoing mid-term reviews by program managers, senior scientists, and external partners. A council consisting of USGS managers and scientists, and representatives from state surveys and the National Park Service reviewed all FEDMAP projects on a regional basis in

1996. In June of 1998, representatives from state surveys, universities, and the private sector participated in the annual FEDMAP program council, where priorities for ongoing projects and new Federal mapping proposals were evaluated. As illustrated in the chart that follows, FEDMAP projects address multiple issues, with geologic mapping as the framework for understanding water and hazard issues receiving the highest funding priority.

The FEDMAP component has developed a new focus in near-surface geologic mapping, hydrogeology, and surficial geology. The Mapping Program's emphasis on basement mapping has decreased, although this type of mapping continues where appropriate to define the framework for resource, hazards, and environmental issues. This change in focus came about as a consequence of tracking and responding to map user needs. Strong partnerships with state geological surveys, growth of cooperative mapping projects with USGS Water District offices, and advice from stakeholders directed the Mapping Program into the near surface. Several projects within the Federal mapping program have conducted regional forums for geologic map users to obtain independent feedback on customer needs. Mapping Program managers are also participating in a bureau-level customer service pilot study, which will be part of the USGS 1998 Customer Service Report.

The National Geologic Map Database, as mandated by the Mapping Act, was implemented as a digital database beginning in 1996. The initial phase of the database is an internet-based catalog of printed maps and mapping-in-progress in the USGS, state surveys, academia, and industry. The index is on the Internet and is being populated with metadata (as of 5/98 the catalog indexes approximately 50% of USGS holdings). The second phase of the project is to provide access and delivery of digital map data on the Internet. In order to deliver digital map data in a form that facilitates GIS use, standards and data models are being developed in partnership with a variety of USGS programs, with state surveys, and with the Geological Survey of Canada.

In order to better serve Department of Interior needs for geologic information, FEDMAP is the primary partner with the National Park Service (NPS) in the "Science in the Parks" initiative. Priorities for mapping projects to address NPS issues were determined by NPS in 1995. An initial suite of more than a dozen mapping projects, with a total funding level of \$2M, were selected by a joint NPS-USGS panel and were begun in 1996. This funding level has been maintained in 1997 and 1998 as new projects have been started each year. These Science in the Parks projects are coordinated with NPS, through NPS-USGS liaisons at the Mapping Program and field operations levels. Geologic mapping projects are providing unbiased framework information on issues that range from potential impacts of lead mining on ground water in the Ozark Mountains to habitat preservation in Death Valley.

FEDMAP has dramatically increased its interactions and leveraged its resources with state agencies and other USGS programs. This is perhaps most evident in cooperative project work with the Ground Water Resources, National Research (NRP) and Cooperative Research programs of the Water Resources Division (WRD), and with the Bureau Ecosystem program. Cooperative projects include: 1) the Middle Rio Grande Basin Project (with the WRD District office in Albuquerque, NRP, Ground-water Resources, New Mexico Bureau of Mines and Mineral Resources, City of Albuquerque, and others), 2) the Southeast Coastal Plain Project (with the South Carolina WRD District and the SC-DNR), 3) the Southern California Areal Mapping Project (with the California Division of Mines and Geology, WRD District Office, and Mojave Water Agency), 4) the Las Vegas Urban Corridor Project (with the Las Vegas WRD sub-District), and 5) the South Florida Ecosystem Project (with the Florida state survey, and with a variety of USGS and other Federal and state partners). Strong cooperation with other Divisions and with Geologic Division programs is also a major factor in the success of several FEDMAP projects, such as the Urban Hazards in Puget Sound, Ozarks Scenic River project (with Mineral Resources and the MO-WRD- District), and infrastructure project and mapping areas of urban expansion and land subsidence in Colorado (with the Mineral Resources Program and the

Colorado Geological Survey). In addition, cooperation with a variety of USGS programs and Divisions is ongoing (e.g., Climate History, Mineral Resources, and Biological, Water, and National Mapping Divisions) in developing the USGS Mojave ecosystem initiative. The initiative-driven efforts have a demonstrated need for geologic mapping and a need for earth science work that addresses multiple issues. Consequently, they provide opportunities for growth of joint work involving all program components and with partners within MSG and other agencies.

Federal mapping projects in the San Francisco and Los Angeles areas led to strong cooperation with the USGS Landslides and Earthquakes programs, as well as with state and county agencies, in responding to hazards related to the 1997 -98 El Nino weather pattern. This, and ongoing joint work with the Landslides program in the Appalachians, suggests that a new landslides initiative could be developed with stakeholders and partners. Cooperative work with the Minerals Program is improving the assessment of the economics of aggregate resources and their relation to urban growth in the Washington- Baltimore urban corridor.

FEDMAP is also contributing to the new Center for Earth Science Information Research (CESIR), a cooperative effort with Stanford University and other partners that began in 1996. The mission is to develop geologic and economic methods to assess the value of earth science information. CESIR grows out of an effort performed on behalf of the Office of Management and Budget in 1991 to assess the value of geologic map information. This initial response resulted in the publication of "Societal Value of Geologic Maps", USGS Circular 1111. Since 1992, more than 10,000 copies have been distributed. New partnerships and joint studies have been established with a number of projects and programs in USGS as a result of a series of short courses on the value of earth science information held during 1997. These range from assessing the economic consequences of ground shaking and liquefaction during earthquakes in California (with the California Division of Mines and Geology) to studies of the economic impacts of ground water contamination.

FEDMAP projects are also garnering significant outside funding to supplement existing funds where priorities are well aligned with program goals. The Mapping Program has long had a strong partnership with the Department of Energy at the Nevada Test Site and Savannah River Site. This effort was shrinking in 1995, but has rebounded and grown in 1997 and 1998. FEDMAP projects have been charged with developing new sources of funding in order to maintain a healthy balance between appropriated and outside funds, while maintaining a commitment to unbiased science. Through numerous funding agreements with the geologic mapping teams, outside funding amounts to approximately 15% of the FEDMAP budget. Funding for international mapping opportunities is also being explored.

FEDMAP is aggressively developing new opportunities for Federal, state, and academic partnerships through the DOI Initiative process. Starting in 1996, program managers and FEDMAP scientists met with state geologists and their staffs from the Great Lakes States to begin developing an initiative for geologic mapping and hydrogeology. Also in 1996, FEDMAP managers began work with the USGS Water Resources Division on a cooperative initiative to address national and local issues related to hydrogeology and ground water resources. Both of these efforts continue to grow. The Great Lakes Geologic Mapping Coalition is a result of a public forum on geologic mapping needs held during 1997 in Indianapolis and attended by 190 participants from 70 agencies. The coalition is now a partnership between the USGS and the state surveys of Indiana, Illinois, Ohio, and Michigan, and includes an ongoing 5-survey pilot project. The Coalition has prepared a prospectus and a draft USGS Circular for a long-term geologic mapping partnership in the region, has briefed Congressional delegations from the four states, and sponsored a workshop with managers of Region V, EPA. Coalition partners continue to consult with state and local map users and partners. Recent meetings with the University of Indiana and Purdue University, which included participation by the Federal Advisory Committee academic representative, indicate an interest among the upper Mid-West universities in designing a training program in surficial geology and GIS to complement the Coalition effort.

Cooperation with the USGS Ground-Water Resources Program led to a new initiative for expanded work in FY 2000, as well as mutual coordination of the FEDMAP component of the Middle Rio Grande Basin project and cooperation in developing other projects of mutual interest. Promising areas for future USGS-state coalition work include geologic mapping and hydrogeologic studies of basins in the Southwest, studies of hydro-stratigraphy and salt-water intrusion in the Southeastern Coastal Plain, and integrated geologic studies of river corridors. Program-managers also participated in the development of a plan to address geologic issues along the nation's river corridors and are planning the first steps in the development of a digital mapping initiative.

FEDMAP has been an active partner with the Florida Geological Survey and a variety of other partners in supporting subsurface geologic mapping and paleo-ecological studies as part of the sustainable ecosystem study of South Florida. In addition, the Mapping Program has participated in planning and GIS development for work in the Yellowstone National Park ecosystem and assumed a primary role in describing surface processes and their connections to biologic processes in the new Mojave ecosystem initiative. Finally, in addition to providing coordination for the Geologic Division, FEDMAP projects are contributing national-scale geologic map information for basement and surficial materials to the National Atlas of the United States.

